PESTS NOT KNOWN TO OCCUR IN THE UNITED STATES OR OF LIMITED DISTRIBUTION, NO. 57: CHRYSANTHEMUM WHITE RUST

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Disease — CHRYSANTHEMUM WHITE RUST

Pathogen — *Puccinia horiana* P. Henn.

Order: Family — Uredinales: Pucciniaceae

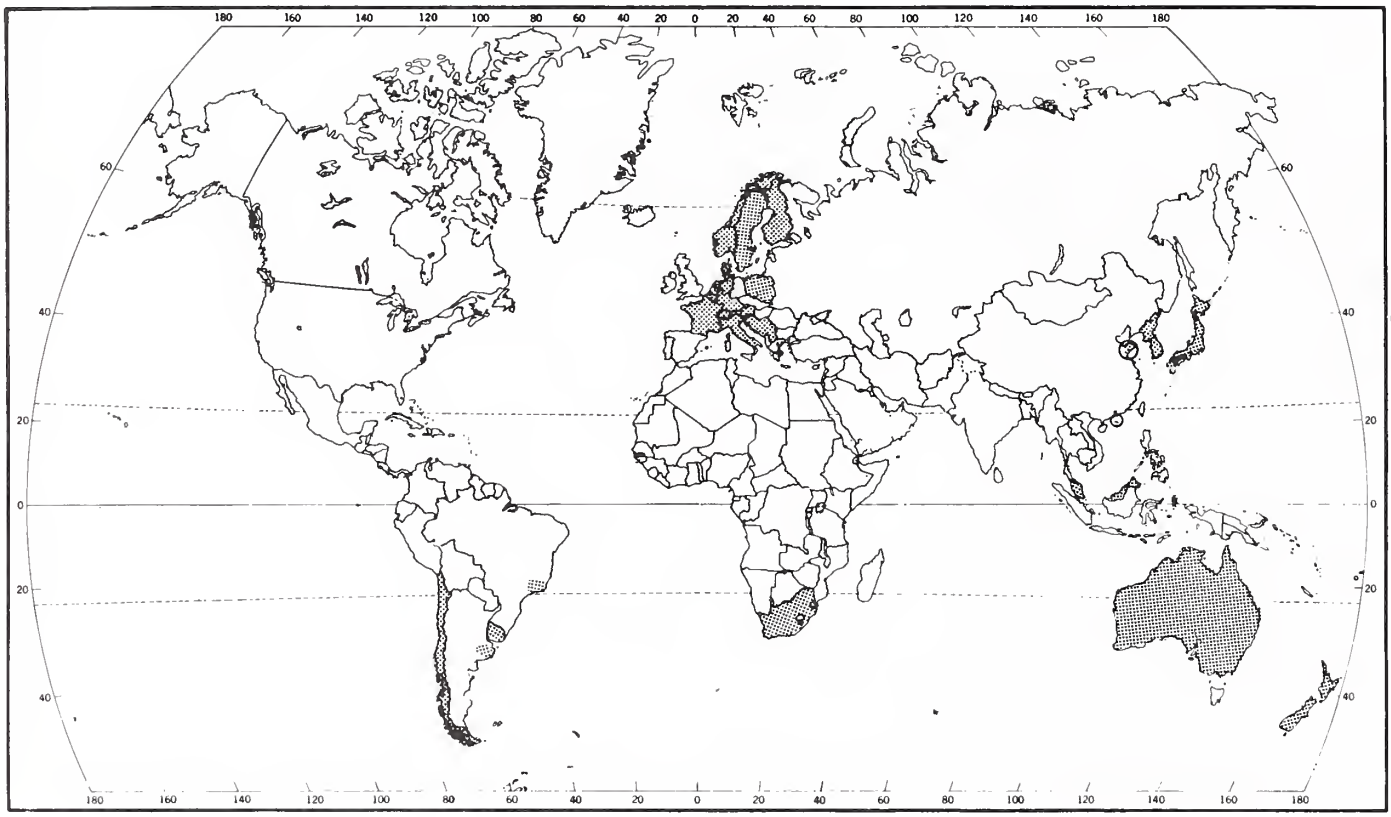
Economic Importance — *Puccinia horiana* is more injurious to the chrysanthemum than *P. chrysanthemi* Roze, an endemic pathogen which incites the chrysanthemum rust, because it infects new shoots early in the spring when the climatic conditions are conducive for its rapid spread (Kusano 1908, U.S. Department of Agriculture 1968). The spots, mostly on the leaves, produced by the white rust pathogen reduce marketability of plants and flowers. Spray residues for control can be unsightly. Plant vigor is reduced (Watson 1971). Once established, the white rust pathogen is very difficult and costly to eradicate.

This pathogen was apparently of little international importance until 1963 when *P. horiana* spread rapidly on infected imported cuttings and is now a serious pathogen in nurseries in Europe, sometimes causing complete loss of chrysanthemum crops. Severe outbreaks have occurred in the United Kingdom, but these have been eradicated. The fungus was similarly contained in France following an initial outbreak in 1967, but appeared again in 1971, and has since spread rapidly throughout the country causing extensive losses (European and Mediterranean Plant Protection Organization 1980). In Poland, the white rust has been the most serious disease of chrysanthemums growing in greenhouses and plastic tunnels since 1979 (Orlikowski and Wojdyla 1981).

Hosts — Various species and cultivars of *Chrysanthemum* have different levels of susceptibility (Dickens 1979, Punithalingam 1968b).

General Distribution — *P. horiana* is indigenous to Japan and China, where it was first noted in 1895 (Peterson, Davis, and Weber 1978). It occurs in AFRICA: South Africa; in ASIA: China (Kiangsu and Kwangtung), Hong Kong, Japan, Korea, and Malaysia; in AUSTRALASIA and OCEANIA: Australia and New Zealand; in EUROPE: Austria, Belgium, Denmark, Finland, France, Italy, Netherlands, Norway, Poland, Sweden, Switzerland, West Germany, and Yugoslavia; in SOUTH AMERICA: Argentina (Buenos Aires), Brazil (Sao Paulo),

Chile, and Uruguay (Commonwealth Mycological Institute 1978 and 1980, de Brotos, Boasso, and others 1981, European and Mediterranean Plant Protection Organization 1980, Gonzalez and Montealegre 1981, Kothekar 1978, Orlikowski and Wojdyle 1981). The disease is listed as occurring in Tunisia (European and Mediterranean Plant Protection Organization 1981), but a reference to the scientific literature is not given. This disease was present in the Canary Islands but has been eradicated (A. W. Pemberton, personal communication 1984).



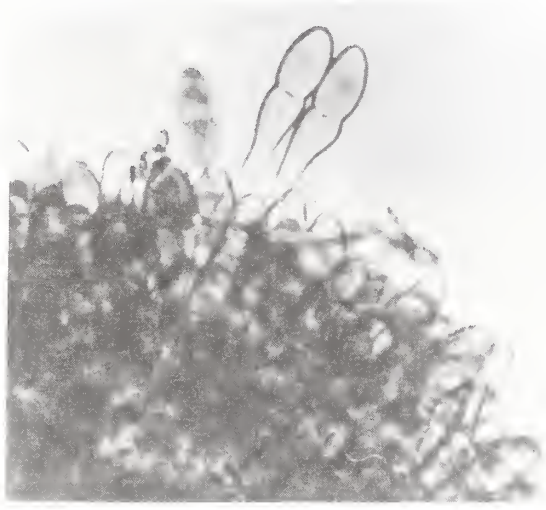
Puccinia horiana distribution map prepared by Non-Regional Administrative Operations Office and Biological Assessment Support Staff, PPQ, APHIS, USDA

The chrysanthemum white rust was found in the United States in 1977-1978 in New Jersey, New York, and Pennsylvania. In all cases, the disease was confined to hobbyist plantings, and was never associated with commercial cut or potted flower establishments. The disease has been eradicated from the United States, with no verified reports of the disease since 1978 (Punithalingam 1968b).

Characters

TELIAL STAGE - Telia hypophyllous, rarely epiphyllous, compact, yellowish to gray, 2-4 mm across. Teliospores (Fig. 1) oblong to oblong-clavate, 32-45 X 12-18 µm, slightly constricted, wall pale yellow 1-2 µm thick. Pedicel hyaline, persistent, up to 45 µm long (Punithalingam 1968b).

(Fig. 1)



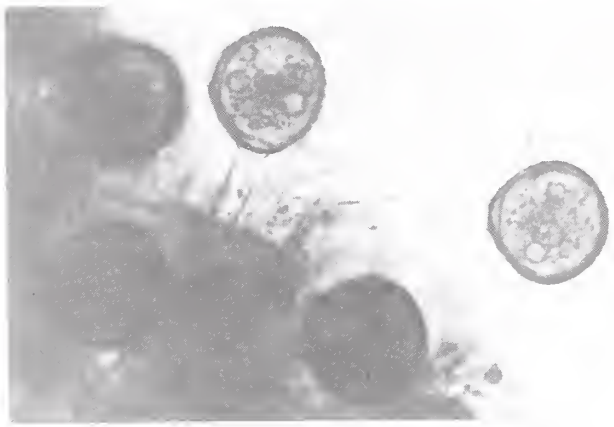
Puccinia horiana teliospores, lateral view (From Peterson, Davis, and Weber 1978).

BASIDIAL STAGE - Basidiospores (sporidia) hyaline, slightly curved, fusiform, 12-18 X 9-15 µm (European and Mediterranean Plant Protection Organization 1980).

Uredial and aecial stages are unknown (Firman and Martin 1968).

Puccinia horiana is separated from two other rust pathogens infecting chrysanthemum, Puccinia chrysanthemi and the species confined to Japan, Phakopsora artemisiae Diet, by the following characters. P. chrysanthemi has brown uredospores (Fig. 2); hypophyllous telia, dark brown teliospores that are oblong to ellipsoidal, rounded and thickened at the apex, scarcely constricted, finely verruculose, 35-57 X 20-25 µm; hyaline, persistent pedicels, 35-60 µm long, and subglobose or pyriform mesospores, 32-37 X 20-21 µm, slightly thickened at the apex. Teliospores of this species are rarely found. They have been observed in Japan but rarely, if at all, in other areas of the world. Phakopsora artemisiae has hyaline to pale yellow uredospores with indistinct germpores, and teliospores in crusts of laterally adherent spores (Punithalingam 1968a). See comparison in Characteristic Damage.

(Fig. 2)



Puccinia chrysanthemi uredospores, lateral view (From Peterson, Davis, and Weber 1978).

Characteristic Damage

The first symptoms on chrysanthemum leaves infected with P. horiana are small yellow to tan patches on the upper surface, up to 5 mm in diameter (Fig. 3). Centers of the

(Fig. 3)

Chrysanthemum white rust on upper leaf surface of chrysanthemum (From Peterson, Davis, and Weber 1978).

patches become necrotic with age (Peterson, Davis, and Weber 1978). On the corresponding under surface, raised, buff or pinkish, waxy pustules are found (Figs. 4 and 5). As the patches on the upper surface become sunken, the pustules beneath become prominent, and under humid conditions, turn whitish when basidiospores are produced. Severely infected leaves wilt, hang down the stem, and gradually dry completely. When crops are extensively affected, pustules may develop on bracts and stems. Infection on flowers has been recorded as necrotic flecking with occasional pustules (European and Mediterranean Plant Protection Organization 1980). The number of pustules per leaf varies with the intensity of infection (Fig. 6) and the cultivar (Peterson, Davis, and Weber 1978).

(Fig. 4)

Pustules of chrysanthemum white rust on under leaf surface of chrysanthemum (From Peterson, Davis, and Weber 1978).

(Fig. 5)

Pustule of chrysanthemum white rust on under leaf surface of chrysanthemum (From Peterson, Davis, and Weber 1978).

(Fig. 6)

Heavy infection of chrysanthemum white rust on under surface of chrysanthemum leaf (From Peterson, Davis, and Weber 1978).

Chrysanthemum is also affected by Puccinia chrysanthemi and Phakopsora artemisiae. In the case of Puccinia chrysanthemi, light green or yellow patches are visible on the upper side of the leaf with corresponding dark brown pustules on the under side. When Phakopsora artemisiae attacks leaves, yellow patches measuring 0.2-0.3 mm form on the leaves; fructification develops on these patches (Kothekar 1978). See comparison in Characters.

Detection Notes

Importation of infected plant material accounts for its rapid spread into new areas. Plants or cuttings of Chrysanthemum spp. capable of propagation are prohibited entry into the United States from countries where the disease occurs (except under departmental permit), or are subject to postentry quarantine from other countries except Canada under Title 7, Part 319.37 of the Code of Federal Regulations.

P. horiana interceptions at U.S. ports of entry totaled 936 for the past 13 years. This pathogen is frequently intercepted from Japan. The white rust pathogen has been found on Chrysanthemum plants or plant parts, especially leaves and stems, imported as cut flowers, propagative material, house plants, and corsages. There were interceptions from the Philippines, Singapore, Thailand, and Vietnam, countries which are not cited in the literature and may represent transshipments from other areas.

1. Hold plants in detention for inspection the following spring if the plants arrive at the growing site during the summer months or early fall (U.S. Department of Agriculture 1968).

2. Inspect field-grown chrysanthemums early in the spring and again later in the fall.

3. Submit for identification, dried and pressed chrysanthemum leaves with white to yellow rust spots (Watson 1971). To prevent disease dissemination, specimens should be shipped in double containers (one container inside another) with screw tops or in double-sealed polyethylene bags.

Biology and Etiology

P. horiana is a microcyclic fungus producing only teliospores and basidiospores (sporidia). It is autoecious, forming all spores on the same host, chrysanthemum (Dickens 1979).

The teliospores can continue to develop almost without interruption through the year depending on the condition of the host and the weather (Kusano 1908). In experiments, teliospores in raised sori on detached leaves held at 17° C survived as long as 8 weeks at 50 percent relative humidity or below, but at higher humidities or buried in dry or moist soil, they survived for only 3 weeks (Dickens 1979, Firman and Martin 1968).

Teliospores can germinate as soon as they are mature without undergoing dormancy (European and Mediterranean Plant Protection Organization 1980). They germinate in place on chrysanthemum leaves to produce a promycelium on which the basidiospores are formed (Kusano 1908). The teliospores and basidiospores develop between 4-24° C and require high humidity and a film of moisture (Firman and Martin 1968).

The complete process of promycelium development and discharge of basidiospores at the optimum 17° C starts within 3 hours. The basidiospores were discharged under laboratory conditions, only when the relative humidity was 96 percent or more, and even at 100 percent relative humidity the production of basidiospores was markedly increased by wetting the pustules (Dickens 1979, Firman and Martin 1968).

Air currents disperse these basidiospores to reinfect chrysanthemum leaves (Dickens 1979). Basidiospores can germinate immediately after their discharge under moist conditions (Firman and Martin 1968). At 17-24° C, basidiospores may penetrate either leaf surface within 2 hours. Thus, 5 hours of wetness is sufficient to establish a new infection (European and Mediterranean Plant Protection Organization 1980).

Spread by airborne basidiospores over long distances is rare and is limited to periods when very moist conditions prevail as the basidiospores begin to desiccate at 90 percent relative humidity and below. In the Netherlands, it was concluded that wind could disperse the basidiospores up to at least 700 m (Dickens 1979, European and Mediterranean Plant Protection Organization 1980).

After infection, the fungus produces abundant hyaline, intercellular hyphae with intracellular haustoria within the leaf (European and Mediterranean Plant Protection Organization 1980). The incubation period in susceptible plants normally takes 7-10 days, teliospores being formed a few days later. Leaves become less susceptible with age, but the oldest leaves

on 5-month-old plants can still be infected. Teliospore pustules are normally produced on the lower leaf surface, at the site of inoculation, although in severe natural infections they may occur above the veins on the upper surface (Firman and Martin 1968).

When the old stems of chrysanthemum die in the fall, the pathogen infects the new growth. Young and old sori can pass the winter in the field in Japan. The ripe spores resist low temperatures until favorable conditions return in the spring (Kusano 1908). The ability of the pathogen to overwinter outdoors elsewhere is unknown (European and Mediterranean Plant Protection Organization 1980) but is restricted by the need for the survival of green host tissue.

Control

Chrysanthemum stools (crowns) can be treated against P. horiana by immersion in hot water at 46° C for 5 minutes. This treatment will prevent the rust from surviving on the stools (Dickens 1978).

Fungicides have been found effective as a protective measure. Sprays applied to both leaf surfaces will prevent cuttings and new plants from being infected (Zandvoort, Groenewegen, and Zadoks 1968).

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